N91-21362

Multiple Sensor Multifrequency Eddy Current Monitor for Solidification and Growth

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Recently we have developed a compact cylindrical multisensor eddy current measuring system with integral furnace to monitor II-VI crystal growth to provide interfacial information, solutal segregation and conductivities of the grown materials. The use of an array of sensors surrounding the furnace element allows one to monitor the volume of interest. Coupling these data with inverse multifrequency analysis allows radial conductivity profiles to be generated at each sensor position. At present work is going on to incorporate these outputs to control the processes within the melt volume. The standard eddy current system functions with materials whose electrical conductivities are as low as 2E2 Mhos/m. A need was seen to extend the measurement range to poorly conducting media so the unit was modified to allow measurement of materials conductivities 4 orders of magnitude lower and bulk dielectric properties. Typically these have included submicron thick films and semiinsulating GaAs. We have used this system to monitor complex heat transfer in grey bodies as well as semiconductor and metallic solidification studies. The ability to provide a multidimensional monitor of processing will be necessary for useful remote process control and understanding.

EDDY CURRENT MONITORING FOR MATERIALS PROCESSING

MULTISENSOR FURNACE CONTROLLER

1. NONCONTACT MATERIAL SENSING FOR CONTROL OF LOW THERMAL MASS FURNACE

2. LOCATING, POSITIONING FOR SIZE CONTROL, SEEDING, AND GROWTH

3. RECORD TRANSIENT PROPERTIES OF MELTING AND GROWTH

MATERIALS

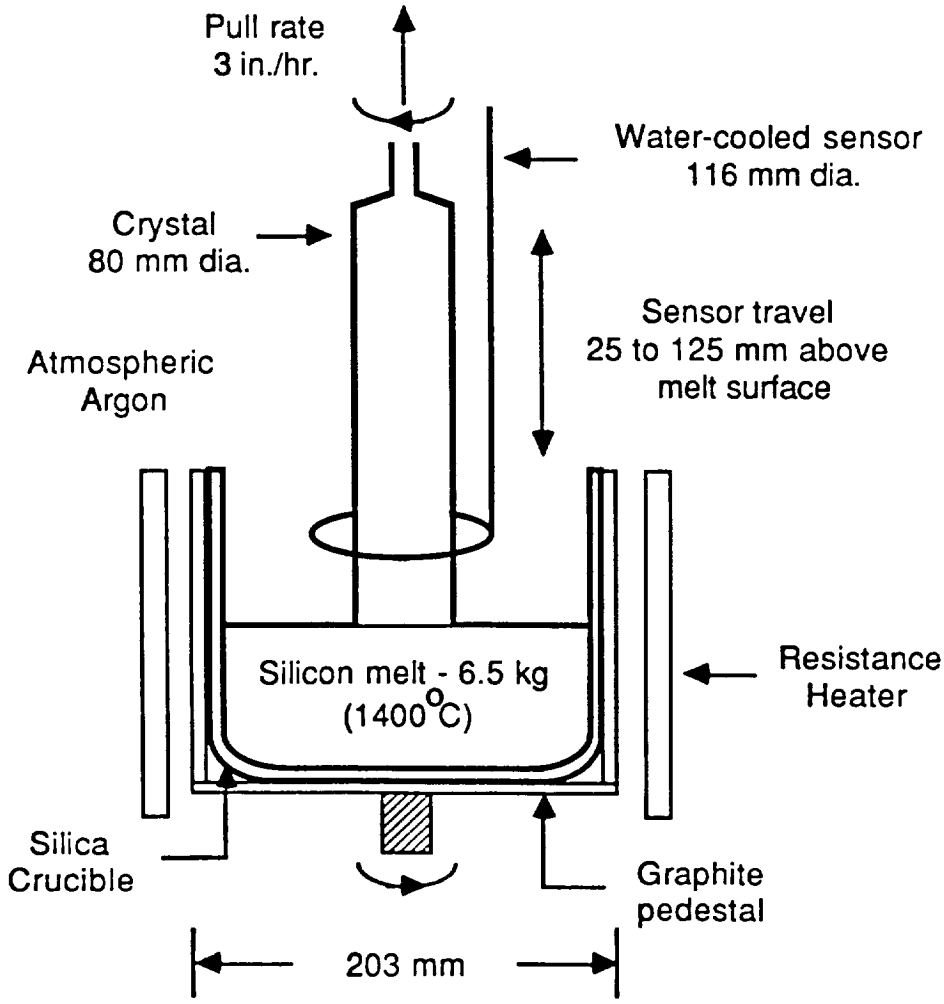
1970	1975	1982	1986	1988	1989
STEEL Induction Pressing Working	Cu and Al Alloys Melting Mixing Phase Sep.	Silicon Temp. Distr. Melt Interface	GaAs Compounding Temp. Distr. Melt Stab.	CdTe HgCdTe Complete Growth Zone Analysis	Aqueous Solutions

HARDWARE

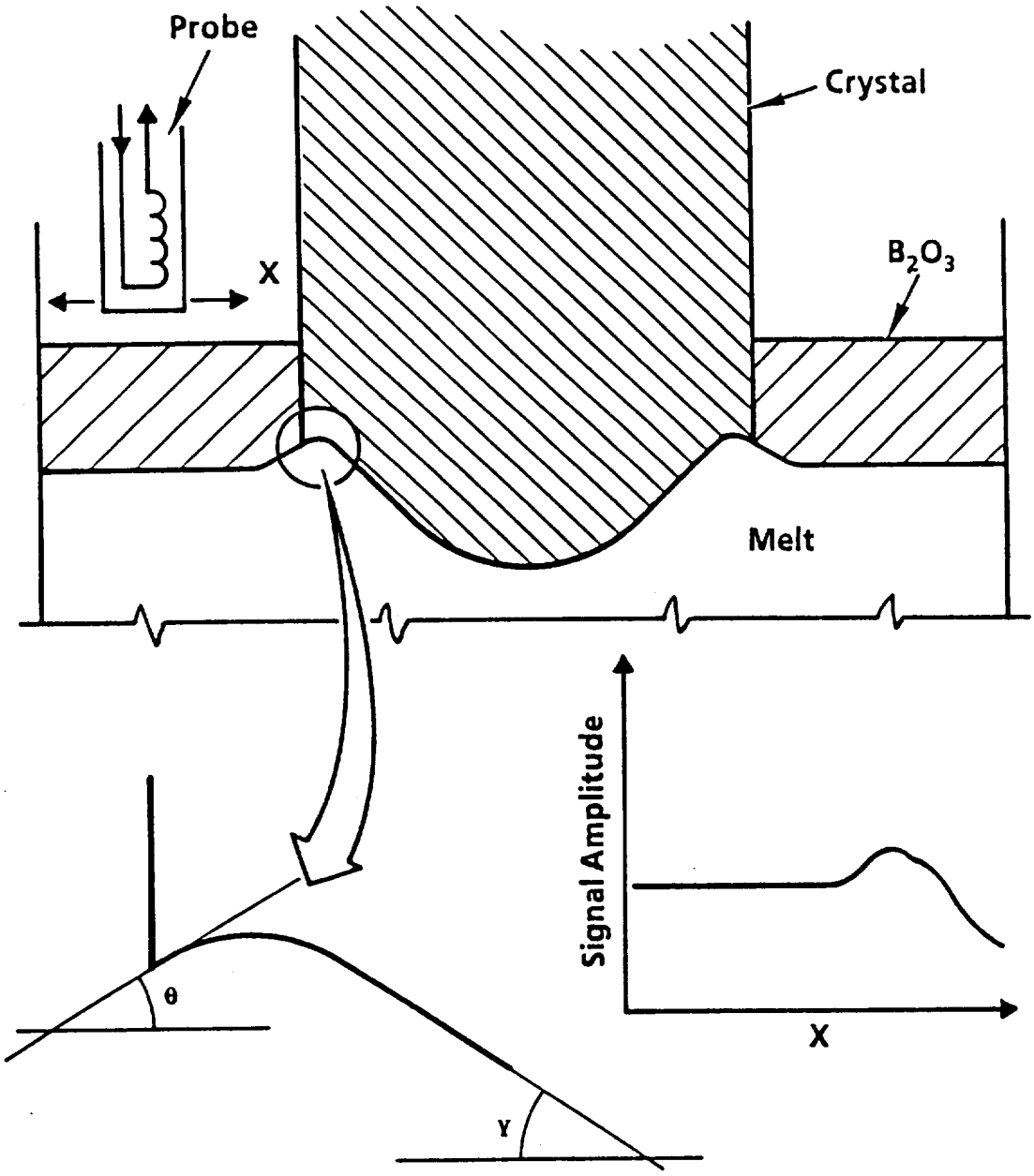
1972	1977-1978	1983	1987	1988
Sensor 1600C	Induction Environments Quadrature Calibration	Simult. Multi- Frequency	Sensor Arrays	Frequncy to 1.2 GHz

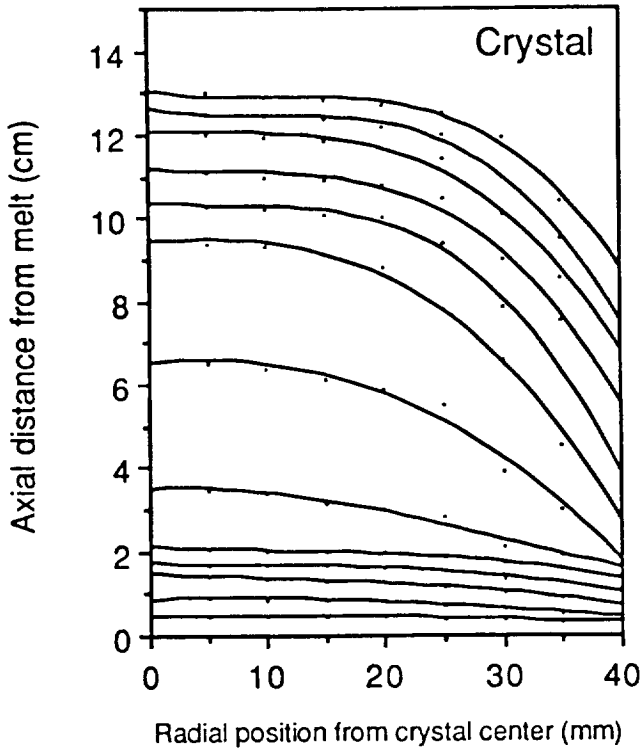
SOFTWARE

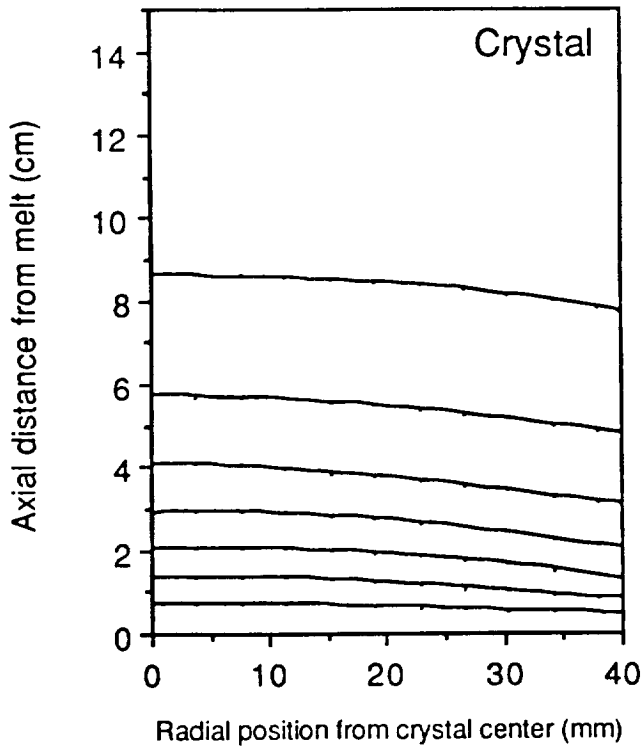
Computer- based data acqu.	Quadrature Relaxation	Inverse Property Analysis	Parallel Processing For Control


Pull rate
3 in./hr.
Water-cooled sensor
116 mm dia.
Crystal
80 mm dia.
Sensor travel
25 to 125 mm above
melt surface
Atmospheric
Argon
Silicon melt - 6.5 kg
(1400°C)
Resistance
Heater
Silica
Crucible
Graphite
pedestal
203 mm

In Situ Eddy Current Analysis of Crystal Interface Shape




Crystal
Axial distance from melt (cm)
0
2
4
6
8
10
12
14
0
10
20
30
40
Radial position from crystal center (mm)


Crystal
Axial distance from melt (cm)
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12
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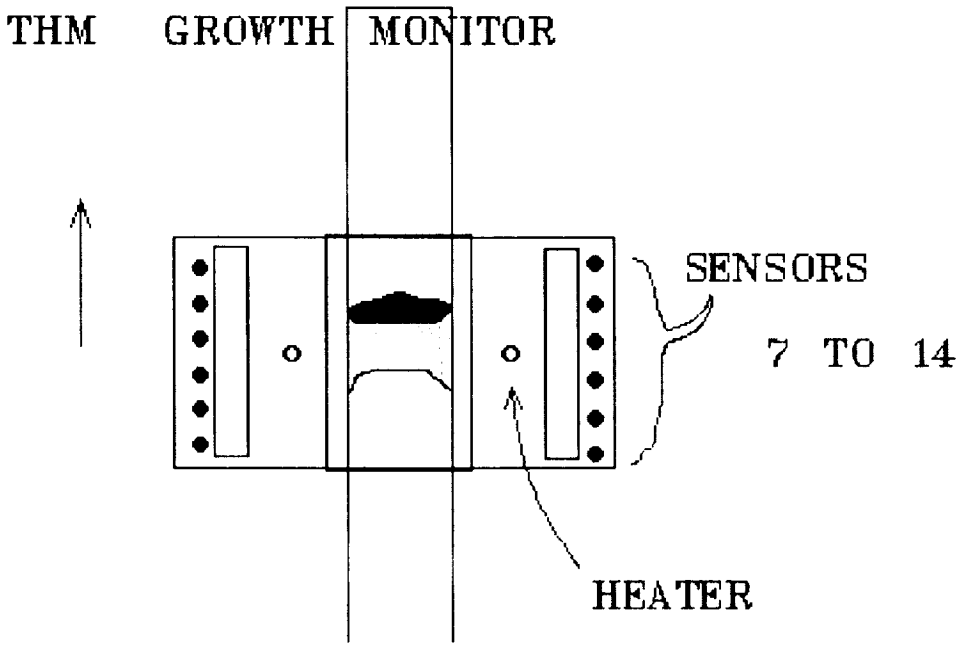
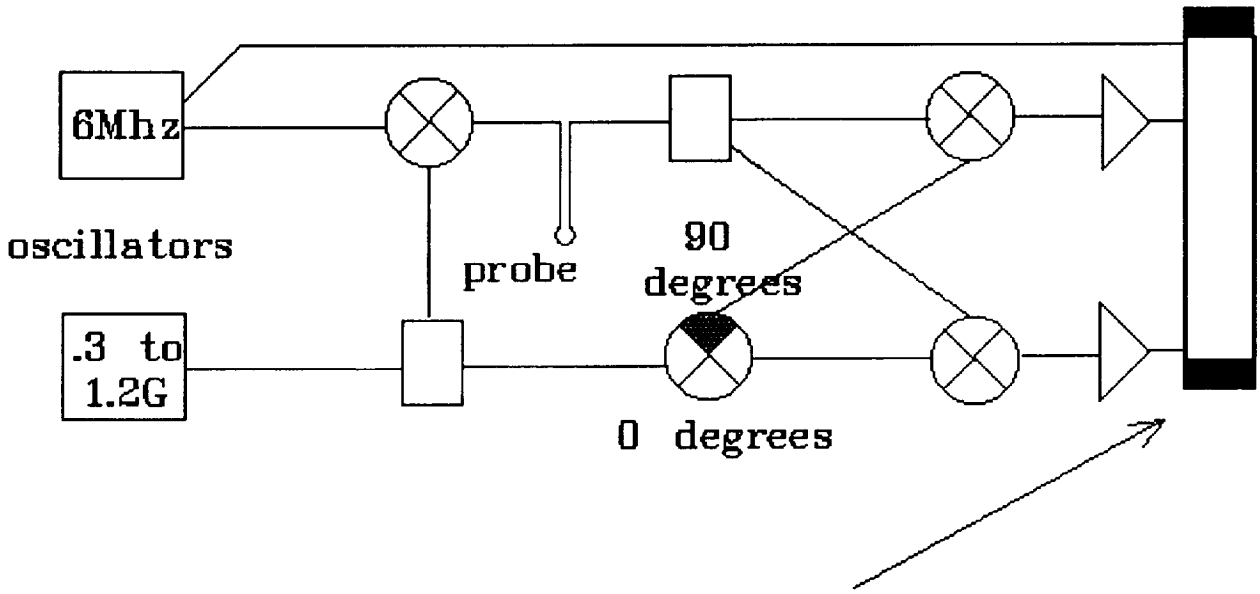
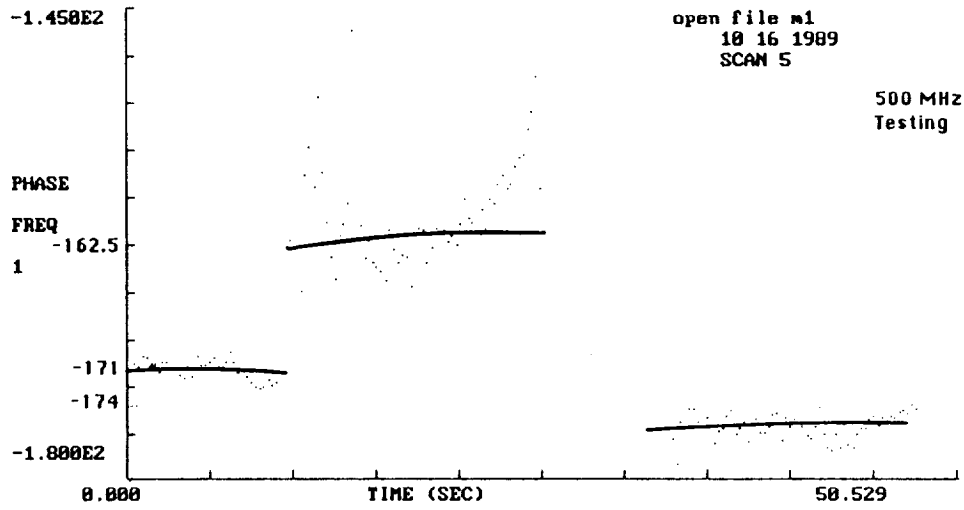
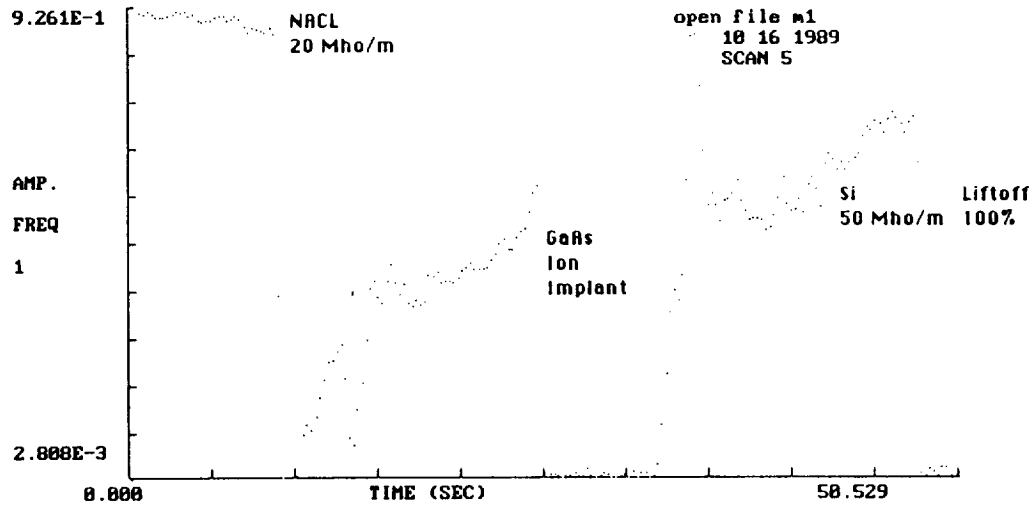
0
10
20
30
40
Radial position from crystal center (mm)

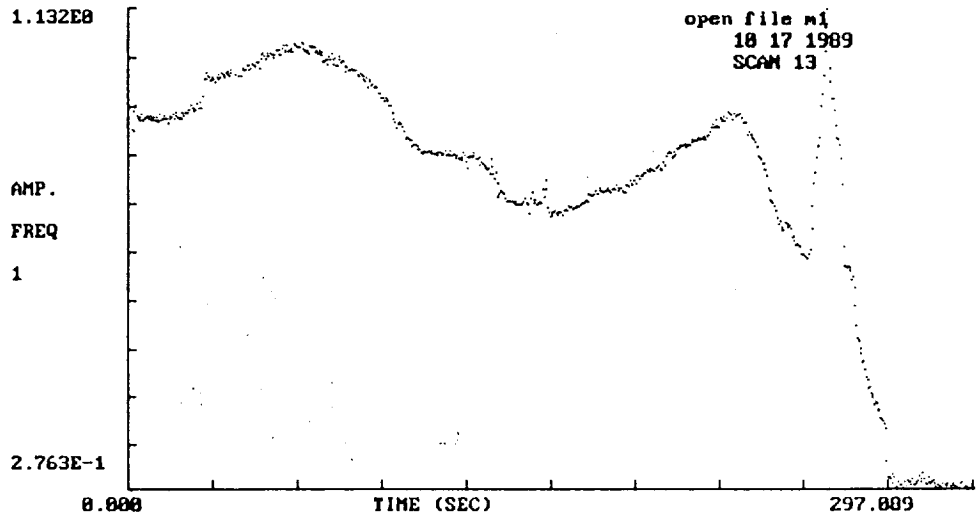

THM GROWTH MONITOR
SENSORS
7 TO 14
HEATER

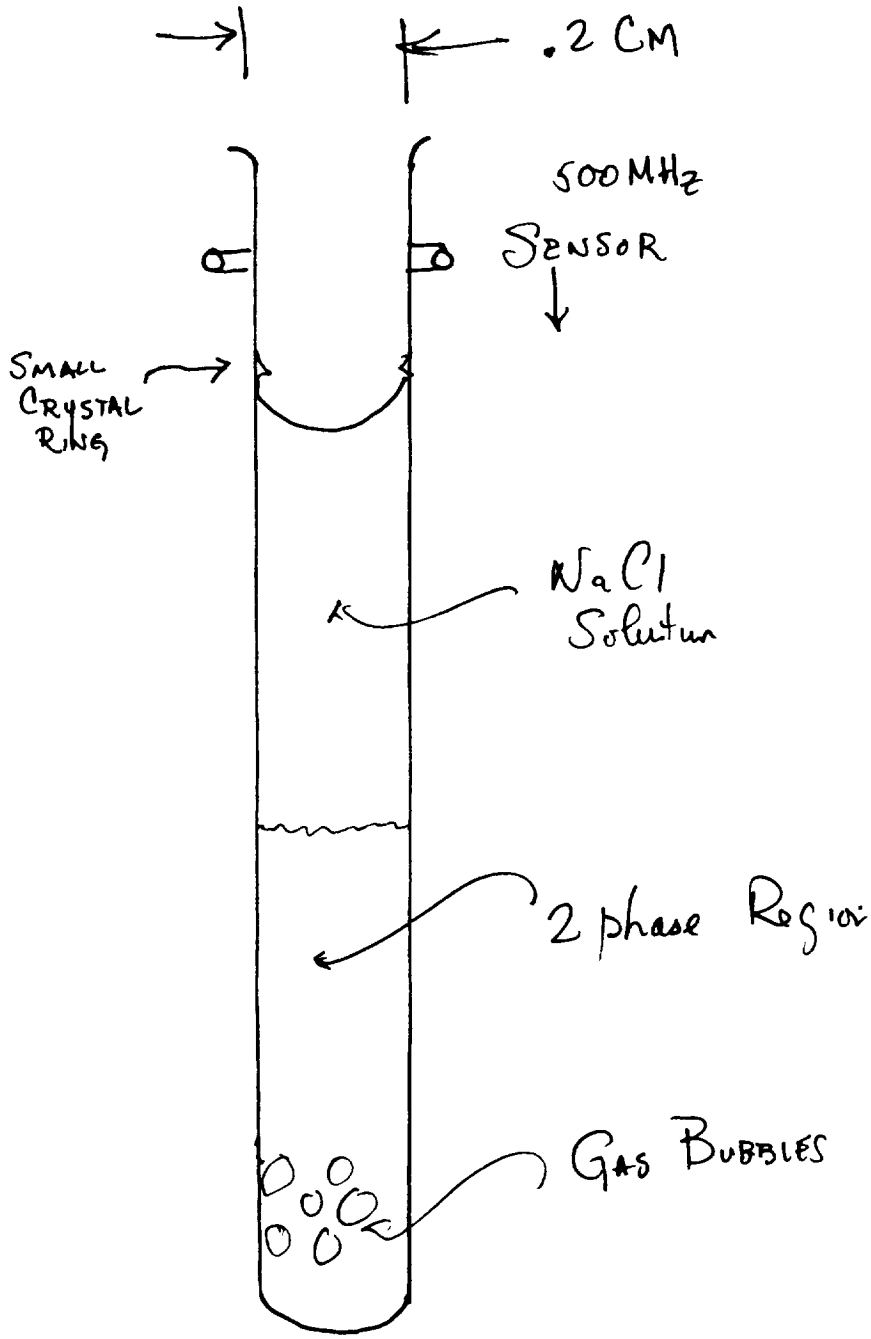


SYCHRONOUS DUAL DETECTOR


-1.450E2
open file m1
10 16 1989
SCAN 5
500 MHz
Testing
PHASE
FREQ
-162.5
1
-171
-174
-1.800E2
0.000
TIME (SEC)
50.529


9.261E-1
NACL
20 Mho/m
open file m1
10 16 1989
SCAN 5
AMP.
FREQ
1
Si
50 Mho/m
Liftoff
100%
GaAs
Ion
Implant
2.000E-3
0.000
TIME (SEC)
50.529


1.132E0
open file m1
10 17 1989
SCAN 13
AMP.
FREQ
1
2.763E-1
0.000
TIME (SEC)
297.009


.2 CM
500 MHz
SENSOR
SMALL
CRYSTAL
RING
NaCl
Solution
2 phase Region
GAS BUBBLES